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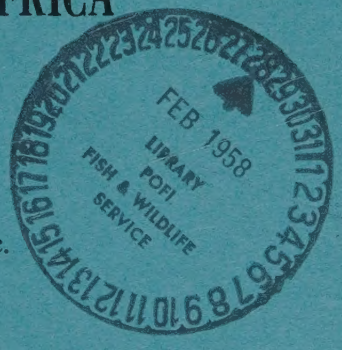
DEPARTMENT OF COMMERCE AND INDUSTRIES

DIVISION OF FISHERIES
INVESTIGATIONAL REPORT No. 28

THE SOUTH AFRICAN PILCHARD
(Sardinops ocellata)

AND MAASBANKER
(Trachurus trachurus)

THE EUPHAUSIIDS OF THE WEST COAST OF SOUTH AFRICA



BY

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1. Summary.

This paper is a further contribution to the series on the general biology of the South African Pilchard, *Sardinops ocellata* (Pappe), and Maasbanker, *Trachurus trachurus* (Linné), and deals with the euphausiids of the west coast of South Africa.

The introduction and discussion of the various methods used, are followed by a discussion of the general occurrence, seasonal variations and distribution of euphausiids. After brief notes on each of the species found, the general occurrence of euphausiids is correlated with certain hydrological factors such as temperature and salinity.

As a result of the investigation, the following findings were made:—

(1) Eighteen species of euphausiids were recorded off the west coast of South Africa.
(2) *Euphausia lucens* and *Nyctiphanes capensis* were the dominant species.
(3) The euphausiids were concentrated in definite areas.
(4) The less common species occurred mainly farther off shore.
(5) Euphausiids were most abundant during late spring, summer and through to the middle of autumn.
(6) The greatest numbers of euphausiid eggs were recorded during spring and summer.
(7) The largest quantities of euphausiids were found where the temperature of the 0–50 metres layer of water was between 11°C and 14°C and the salinity between 34·80‰ and 35·10‰.
(8) Both phytoplankton and zooplankton served as food for the euphausiids.

2. Introduction.

The data on which this report is based were obtained from plankton collections made along the west coast of South Africa during routine voyages of R.S. *Africana II*, from April, 1954, to March, 1956, in connection with the pilchard and maasbanker research programme.

The network of stations worked is shown in Plate 1. This includes the St. Helena Bay area where the majority of commercial catches of pilchards and maasbankers are made. A large amount of deep-sea trawling also takes place in this area. Collections were made once a month at all stations, but after March, 1955, the collection of data at Station S was discontinued, while Stations Y and Z (see Plate 1) were added to the list. This group of stations covers an area of approximately 4,800 square miles (Marchand, 1951).

Euphausiids were seldom present in the stomach contents of the pilchards examined in the course of the routine sampling of commercial catches. Those found were mainly juvenile stages such as *furcilia* and *nauplii*. Euphausiids were present in the stomachs of approximately 30 per cent of the maasbankers obtained from commercial catches made in shallow water. On an average euphausiids constituted about 50 per cent of the stomach contents throughout the year. It is interesting to note that the stomachs of about 83 per cent of the maasbankers caught in deep water by means of the otter trawl-net, contained euphausiids. Here they constituted as much as 64 per cent of the stomach contents.

According to Davies (1949) euphausiids are found in large numbers throughout the year in the stomachs of young stockfish (*Merluccius capensis*), juvenile rat-tails (*Coelorhynchus fasciatus*), young John Dory (*Zeus capensis*) and young sancords (*Helicolenus maculatus*). Throughout the year euphausiids formed approximately 46 per cent of the general diet of stockfish in the length category of 200–600 mm. In the case of sancords euphausiids occurred in the stomachs of fish of practically all sizes and constituted 14 per cent of the diet of all sancords examined.

All these younger fish as well as young and adult maasbankers and the adults of smaller species such as lanternfish (*Myctophum* spp.) feed to a large extent on euphausiids (Davies 1949). All these fish serve as a source of food for larger fish in the area and therefore euphausiids are of primary importance in the food cycle in the sea off the West Coast.

3. Methods.

During each routine voyage of R.S. *Africana II*, three plankton tow-net hauls were made at each station. The plankton nets are of the standard types used by R.R.S. *Discovery II* and full descriptions are available in the *Discovery Reports* (Kemp, Hardy and Mackintosh, 1929). The following plankton tow-nets were used, viz. the N70V or vertical net used from 100 metres, or 5 metres from the bottom if the depth was less than 100 metres, to the surface; the N100H or surface net was towed for 10 minutes at 0 metres at each station, and the N100B plankton tow-net was towed from 150 metres, or 5 metres from the bottom where the

depth was less, to the surface with the ship moving at about 1½–2 knots. At the shallower stations, K, O, and X, the N100B net was towed from a depth of 125 metres, at Q from 90 metres and at Stations M and N from 50 metres. As Station P near Stompneusbaai was a very shallow station, N100H tow-net hauls were made at the surface only. All these hauls were made during daylight.

All samples obtained from N100B plankton tow-net hauls were examined for euphausiids.

From April, 1954, to March, 1955, a number of N100B plankton tow-net hauls were made after dark. Two of these stations were occupied during each monthly routine cruise except in February, 1955, when only one was worked.

During the second year of investigation a number of vertical hauls were made with N70 plankton closing-nets at Station Y at the following depths: from 600 to 400 metres, 400 to 200 metres and from 200 metres to the surface. Catches made in these closing nets during the months of August, October, November, 1955, January, February and March, 1956, were examined for euphausiids.

The plankton catches were preserved in 10 per cent neutral formalin, after which the euphausiids were sorted, identified, counted, measured and the data recorded. Where large quantities of euphausiids were present, the settled volumes were measured and the total number calculated by counting the number contained in a smaller volume, e.g. 50 cc.

As the mesh openings of the N100B plankton tow-nets are too big to hold euphausiid eggs, catches made by means of the N70V plankton tow-net were examined for euphausiid eggs.

In addition to the plankton net hauls, temperature readings and water samples were taken at each station at 0, 10, 20, 30, 40, 50, 60, 75, 100, 150, 200, 250, 300 and 400 metres, according to the depth of the station.

A continuous thermographic record of the surface temperature was taken throughout the routine cruise.

Weather observations were taken at four-hourly intervals and at each station.

4. General Occurrence and Distribution.

During the two years of investigation, 18 species of euphausiids were found in the research area, off the West Coast, viz:—

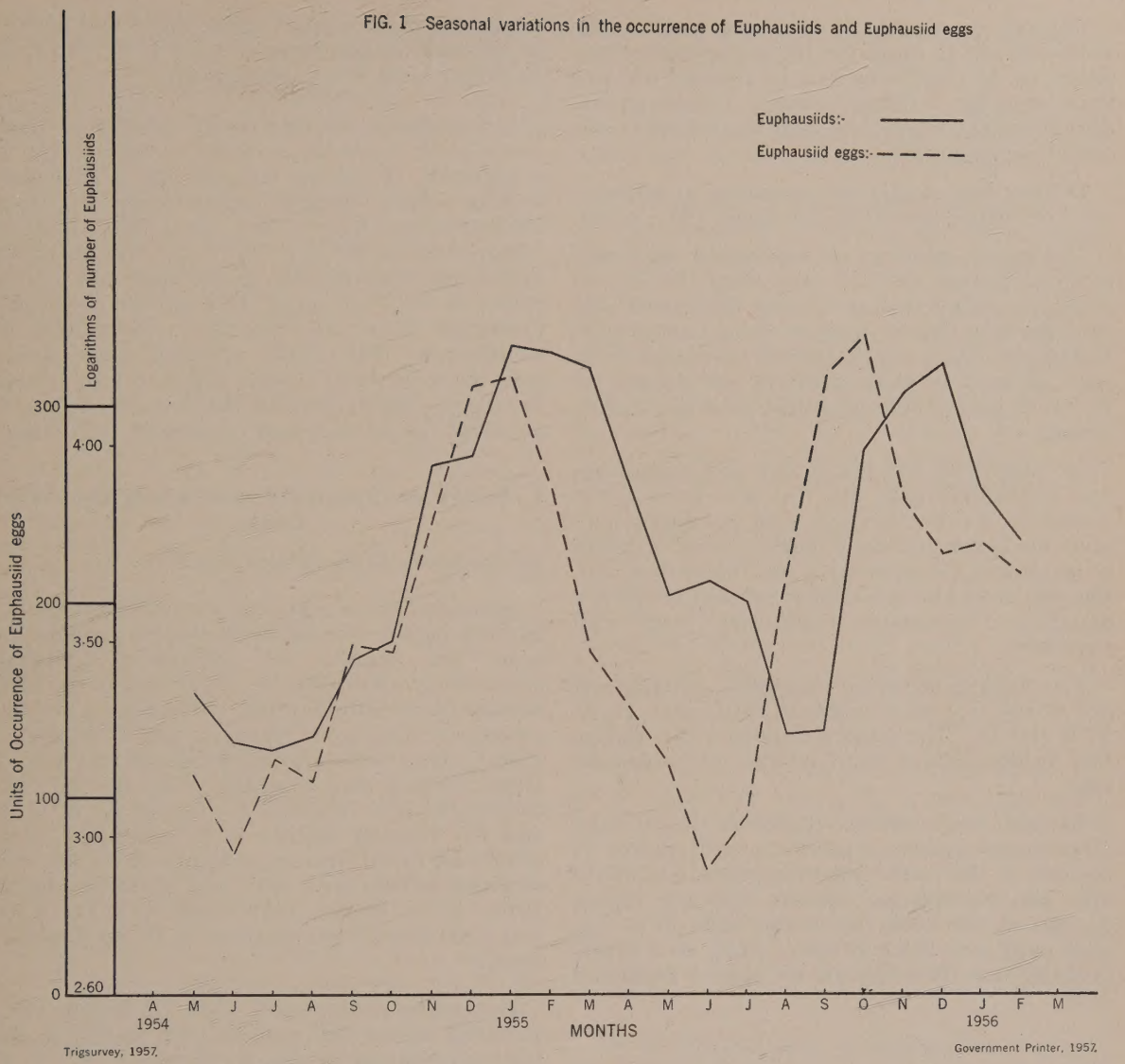
(*a*) *Euphausia lucens* (Hansen);
(*b*) *Euphausia recurva* (Hansen);
(*c*) *Euphasia similis var. armata* (Hansen);
(*d*) *Euphausia similis* (Sars);
(*e*) *Euphausia hanseni* (Zimmer);
(*f*) *Euphausia mutica* (Hansen);
(*g*) *Nyctiphanes capensis* (Hansen);
(*h*) *Thysanoëssa gregaria* (Sars);
(*i*) *Thysanoëssa parva* (Hansen);
(*j*) *Nematoscelis megalops* (Sars);
(*k*) *Nematoscelis microps* (Sars);
(*l*) *Stylocheiron carinatum* (Sars);
(*m*) *Stylocheiron longicorne* (Sars);
(*n*) *Stylocheiron elongatum* (Sars);
(*o*) *Stylocheiron abbreviatum* (Sars);
(*p*) *Stylocheiron affine* (Hansen);
(*q*) *Stylocheiron maximum* (Hansen);
(*r*) *Nematobrachion flexipes* (Ortman).

Of these 18 species only three were present during every month of the year, namely *Euphausia lucens*, *Nyctiphanes capensis* and *Thysanoëssa gregaria* (see Tables I and II). *Euphausia lucens* and *Nyctiphanes capensis* were generally the dominant species in the catches. The other less common species were mostly found at the stations farther off shore but never in large numbers.

The largest catches were made at Station R near the entrance to Saldanha Bay where one haul made during February, 1955, yielded over 800 cc. settled volume of euphausiids, the majority of which were *Euphausia lucens*. Euphausiids were particularly abundant at the stations in area B shown in Plate I. The catches made in St. Helena Bay itself, as well as at stations farther off shore, were generally poor. At the former nine stations (area B) the euphausiids accounted for about 30 per cent of the total plankton catch made by means of the N100B plankton tow-net, while they constituted approximately 15 per cent of the catches made at the latter stations.

Figure 1 shows the seasonal variation in the abundance of euphausiids and euphausiid eggs obtained from the N100B plankton tow-net hauls and vertical N70V plankton tow-net hauls respectively, in the routine area. In order to present the seasonal variations in the occurrence of euphausiids more clearly, the curve was smoothed; the average of the totals being calculated as follows: Assume that in four consecutive months a, b, c and d constituted the total number of individuals for the

FIG. 1 Seasonal variations in the occurrence of Euphausiids and Euphausiid eggs



first, second, third and fourth month respectively, then the average is calculated as $\frac{a+b+c}{3}$ for the second month, $\frac{b+c+d}{3}$ for the third month, etc. As the numbers for the various months show a very wide range, viz., from 1,682 to 18,261, the logarithms of these numbers were used in plotting the graphs.

From the graph it is seen that the euphausiids were most abundant during the period from late spring through summer to mid-autumn, while much smaller quantities occurred during the winter months.

On examining the stomach contents of 55 euphausiids comprising 25 *Euphausia lucens*, 25 *Nyctiphanes capensis* and 5 *Nematoscelis megalops*, the greater proportion of the stomach contents was found to consist of small unrecognisable particles. In a number of the stomachs, however, *Dinoflagellata* such as *Prorocentrum* and *Dinophysis*, as well as traces of the remains of copepods were identified. It is therefore evident that euphausiids may feed on phytoplankton as well as zooplankton.

It is interesting to note that the months of maximum occurrence of euphausiids correspond with the period of increased phytoplankton bloom (de Jager, 1957).

The data on euphausiid eggs were treated in the same manner as those for the euphausiids themselves, i.e. by calculating moving averages for each three months. These averages were plotted directly instead of plotting their logarithms as was done for euphausiids.

The numbers of eggs were expressed as arbitrary units of relative abundance (de Jager, 1954, p. 16).

The largest numbers of euphausiid eggs were recorded during the first year from the end of spring to mid-autumn and during the second year from the beginning of spring to the end of summer. During the winter months of both years euphausiid eggs occurred in small numbers and during the month of June in both years they were particularly scarce.

On comparing the two graphs for euphausiids and euphausiid eggs for the two years under discussion, it is interesting to note that during both years the largest number of eggs occurred a month or two before the euphausiids were most abundant. The eggs were also recorded in smallest numbers a month or two before euphausiids were least abundant.

The majority of the eggs occurred at Stations R and Q and to a lesser extent at Stations O, H, X, V, B and D. The inshore stations in St. Helena Bay yielded only a small number of euphausiid eggs.

As the two species *Euphausia lucens* and *Nyctiphanes capensis* constitute approximately 99 per cent of the total euphausiid population of the area and *Nyctiphanes capensis* does not release its eggs in the water but carries them in an egg sack until they hatch (Boden, 1955), it is highly probable that these eggs are the eggs of *Euphausia lucens*.

5. The Relationship between the Occurrence of Euphausiids and Hydrological Factors.

The mean integral values of temperature and salinity of the 0–50 metres layer were calculated for each station for each of the two years of investigation (see Tables III, IV, V and VI).

These data show that the euphausiids were particularly abundant in the area where the mean integral temperature of the 0–50 metres layer ranged from 11·0°C to 14·0°C, thus including area B as shown in Figure 1. The mean integral values of salinity for the 0–50 metres layer of this area varied from 34·78‰ to 35·12‰. Large quantities of euphausiids were found at stations where the mean annual temperature and salinity of this layer ranged from 12°C to 13°C, and from 34·80‰ to 34·92‰, respectively.

It was also found that during months in which considerable increases occurred in the number of euphausiids at certain stations, the 0–50 metres average mean integral temperature at these stations ranged from 9·60°C to 11·30°C, and the salinity from 34·66‰ to 34·75‰. It is therefore evident that relatively low temperature and salinity values in the 0–50 metres layer provide conditions favourable for a rapid increase in the number of euphausiids. This colder upwelled water stimulates phytoplankton blooms which in turn sustain the copepods with the result that more food is made available for an increased euphausiid population.

6. Notes on Species Found along the West Coast.

(*a*) *Euphausia lucens* (Plates 2 and 3).

Euphausia lucens was the most common species and it occurred over the entire area throughout the year. The number of specimens obtained, amounted to approximately 76 per cent of the total number of euphausiids found. During the summer months of December, January and February in particular, as well as during November and March, large numbers were recorded. The greatest concentrations were observed at Stations X. R, Q, O and L. Thus at Station L in December, 1954, 4,000 were found whereas at Station R, 16,000 were recorded in February, 1955, and 12,000 in March, 1955; in November, 1955, totals of 9,000, 5,600 and 5,000 were taken at Stations X, Q and R respectively.

During the period April, 1954, to March, 1955, *Euphasia lucens* was concentrated mainly in the vicinity of stations in area B (Stations U, W, G, X, R, Q, O, L, E, T and K) as shown in Plate 2. The mean integral temperature and salinity values of the 0–50 metres layer of this area for the year were 13·33°C and 35·02‰ respectively. The greatest concentrations occurred at Stations R, Q, O and L with an 0–50 metres layer mean integral temperature of 12·23°C and a salinity of 34·87‰.

During the second year of observation, i.e. from April, 1955, to March, 1956, concentrations of this species were found closer inshore at the stations in area B (Stations U, V, X, G, H, R, F, I, Q, O, N, K and L) as shown in Plate 3, with a 0–50 metres layer mean integral temperature and salinity of 13·02°C and 34·97‰ respectively. The largest

concentrations of *Euphausia lucens* occurred further south than during the first year at Stations X, R and Q with a mean annual temperature and salinity of 12·00°C and 34·83‰ respectively as against 12·44°C and 34·91‰ respectively for the previous year.

Approximately 70 per cent of the total number of *Euphausia lucens* consisted of adult stages, while approximately 30 per cent consisted of larval stages, being mainly late larval and *furcilia* stages. The presence of small quantities of the latter stages may be ascribed to the fact that the mesh openings of the N100B plankton tow-net were too large to prevent some of the younger stages from escaping. Although the juvenile stages occurred in smaller numbers, they showed the same pattern of distribution as the adults (Plates 4 and 5). As in the case of the adult stages, the area in which the largest numbers were obtained during the first year of investigation was farther off shore than during the second year, but during the latter period these stages were concentrated mainly in area B of Plate 5 (Stations V, X, R, H, Q, O and L) where the mean integral range of temperature of the 0–50 metres layer was from 11·21°C to 14·13°C and the mean integral salinity varied from 34·78‰ to 35·12‰. No large concentrations such as those which occurred in the case of the adult stages, were however found inshore at Station N and farther off shore at Stations G, F, I and K. During the period April, 1954, to March, 1955, euphausiid larvae occurred mainly at stations (see Plate 4, area B) where the mean annual salinity and temperature values of the 0–50 metres layer (excluding Station W) ranged from 34·83‰ to 35·08‰ and from 11·69°C to 14·37°C respectively. On comparing the results for both years, it appears that the most favourable conditions for larval development prevail at mean integral temperature and salinity values of from 11°C to 14°C and from 34·80‰ to 35·10‰ respectively for the 0–50 metres layer of water.

(*b*) *Nyctiphanes capensis* (Plates 6 and 7).

This species accounted for approximately 23 per cent of the total number of euphausiids recorded in this area.

Although *Nyctiphanes capensis* was present at all stations except the deeper stations Y and Z, this species occurred mainly at inshore stations (area B in Plates 6 and 7). During the two years this species was to a large extent limited to Stations X, R, Q, L, K and to a lesser extent to Stations O and N. At these stations which are situated within or on the edge of the 100 fathom contour area, *Nyctiphanes capensis* constituted about 28 per cent of the total number of euphausiids.

The mean annual temperature of the 0–50 metres layer of this area ranged from 10°C to 13°C, while the salinity varied from 34·70‰ to 35·00‰.

As in the case of *Euphausia lucens*, it was found that this species was concentrated closer inshore during the second year of investigation than during the period April, 1954, to March, 1955. During the latter year, for example, large quantities of *Nyctiphanes capensis* were found at Station K, while the species was relatively scarce at Station N. In the course of the following year, it was very scarce at Station K but occurred in much greater quantities at Station N. Even at all the stations farther off shore *Nyctiphanes capensis* was present in smaller quantities than during the first year.

(*c*) *Euphausia recurva* (Plate 8).

Although this species occurred sporadically, it constituted approximately 0·26 per cent of the total number of euphausiids recorded. Although *Euphausia recurva* occurred during only four months, viz. April, May, June and August, of the first year of investigation, the total number obtained was much larger than that obtained during the second year. During the latter period this species appeared in the net catches during all the months except April and May. The greater total abundance during 1954 is mainly due to the fact that 191 individuals were found in a single catch made at Station S during May. Although *Euphausia recurva* occurred during only four months, viz. June, July, September and December, at certain stations, the regular occurrence during the second year is without doubt due to the addition of Stations Y and Z.

The largest quantities of *Euphausia recurva* were found at the deeper stations farther south, namely Y, Z, S, T, G, W and X (Plate 8, area A). At Station X this species appeared only once, however, namely during August, 1954, when 16 individuals were found.

At the other Stations (Plate 8, area B) A, B, C, F, H, R and V, where it also occurred, a few individuals were found only once during the two years.

At Station Y, where this species occurred fairly regularly, it was mostly present in the N70V plankton closing-net catches made at depths of from 400 to 200 metres. Nearer the surface, from 200 to 0 metres, the catches were smaller, and at

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greater depths, from 600 to 400 metres, catches of this species were even smaller.

(*d*) *Euphausia similis var. armata* (Plate 9).

This species did not occur in large numbers or very often in the plankton catches. The following table shows the occurrence of *Euphausia similis var. armata* during the two years.

Year.	Month.	Area.	Stations.
1954.....	June.....	A	E, F.
1954.....	July.....	B	V, X.
1955.....	January....	C	F, S.
1955.....	March.....	D	C, D, H, K, L, M.
1955.....	May.....	D	C.
1955.....	December..	E	F, G, T.

In addition to the above, one specimen was also found during February, 1956, at Station Y in the N70V plankton closing-net at a depth between 400 and 200 metres. During March and January, 1955, a considerable number was also found at Stations 2868, 2867 and 2783 near Stations B, S and F, where the hauls were made during the night.

(*e*) *Euphausia similis* (Plate 12).

Specimens of this species were found only during March, 1955, when one adult female was found at Station C and five juvenile stages near Station Y at Station 2867 where hauls were made during the night.

(*f*) *Euphausia hanseni* (Plate 12).

Only two specimens of this species were found at the routine stations, one during September, 1954, at Station E and the other during November, 1954, at Station J. In March, 1955, two individuals were also found during the night in a N100B plankton tow-net haul made at Station 2868 near Station B. Although these specimens were obtained during different months, they were all found in roughly the same area.

(*g*) *Euphausia mutica* (Plate 12).

Only one adult female was found i.e. at Station Y in an N70V closing-net haul made between 400 and 200 metres during March, 1956.

(*h*) *Thysanoëssa gregaria* (Plate 10).

Although this species constituted only about a quarter per cent of the total number of euphausiids, it was the fourth most abundant species in the plankton catches. This species also appeared every month, mainly at the stations farther off shore (area A), and was also more abundant at the stations in the southern part of the routine area. At the stations in the vicinity of St. Helena Bay (area C) it was very scarce. It was, for example, never found at Stations L and M during the two years and only one individual was found at Station N in August, 1954, 2 at Station K in March, 1955, 2 at Station 0 (one in July, 1954, and one in October, 1955), and only one during September, 1955, at Station Q.

Thysanoëssa gregaria occurred most regularly at Stations A, Z and Y in area A, while the largest single concentration, namely 76 individuals, was also found at Station Y during February, 1956. Approximately 75 per cent of the total catches consisted of immature stages.

(*i*) *Thysanoëssa parva* (Plate 12).

Only one adult male and two larvae were found i.e. at station J during May, 1955.

(*j*) *Nematoscelis megalops* (Plate 11).

This species, which occurred mainly at the deeper stations (Plate 11, areas A and B) i.e. A, B, C, Z, Y, S, T, G, H and W, was never found in large concentrations. At the above-mentioned stations the mean temperature of the 0–50 metres layer of water was above 15°C. At Station Z, the western-most station of the routine area, the largest single catches were made.

In the plankton closing-net catches made at Station Y twenty-two individuals of this species were found, namely one during November, 1955, and February, 1956, respectively, and 19 during March, 1956, in the hauls made from 200 to 0 metres, and one during February, 1956, in the plankton closing-net haul made from 400 to 200 metres.

This species occurred from summer to mid-autumn and in March, 1956; in particular it had a fairly wide distribution.

(*k*) *Nematoscelis microps* (Plate 12).

One adult female of this species was found at Station J during November, 1954, a larva at Station I during December, 1955, another larva at Station J in November, 1955, and one adult female in March, 1955, at Station 2867 near Station Y, where the haul was made during the night.

(*l*) *Stylocheiron carinatum* (Plate 12).

A total of 27 specimens was obtained during the months of June, September, October, November and December, 1954, and April, June and October, 1955, at Stations A, B, C, D, G, J, S and Z. TA. species therefore occurred mainly at stations farther off shore, particularly at Stations and C

(*m*) *Stylocheiron longicorne* (Plate 12).

A total of 18 specimens was found in the course of the two years during the months of January, March, June to September and November at Stations A, C, E, G, I, L, V, X and Z. With the exception of one adult male found at Station E in August, 1955, and one adult female found at Station L in July, 1955, all the specimens were still in the larval stages.

(*n*) *Stylocheiron maximum* (Plate 12).

Three larvae of this species were found. One was caught at Station G during July, 1954, one at Station B during November, 1955, and one in a N70V plankton closing-net haul made from 200 metres to the surface, at Station Y during August, 1955.

(*o*) *Stylocheiron elongatum* (Plate 12).

Only seven larvae were found during the two years. One was found as Station S in March, 1955, two at Stations K and Q during September, 1955, one each at Stations B, I and Z during December, 1955, and one near Station Y at Station 2867. In the latter case a haul was made during the night in March, 1955

(*p*) *Stylocheiron abbreviatum* (Plate 12).

Only three larvae and one adult of this species were found, viz. two larvae at Station T in October, 1955, one adult during November, 1955, at Station K and one larva at Station A in January, 1956.

(*q*) *Stylocheiron affine* (Plate 12).

Three specimens of this species were found, namely two adult females at Station A (one in May, 1954, and one in November, 1955), and one larva during October, 1955, at Station E.

(*r*) *Nematobrachion flexipes* (Plate 12).

One larva of this species was found at Station Y in August, 1955, in a N70V closing-net catch made from 400 to 200 metres.

7. Acknowledgements.

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Table I.

Number of Euphausiids Found at Routine Stations. April, 1954—March, 1955.

	1954									1955			Total
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	
Euphausia lucens.....	3,494	1,054	1,974	1,475	823	1,808	3,850	1,794	6,193	5,774	19,907	17,952	66,098
Nyctiphanes capensis.....	161	42	123	422	121	732	1,083	241	14,053	771	8,040	675	26,464
Euphausia recurva.....	46	197	7	—	70	—	—	—	—	—	—	—	320
Euphausia similis var. armata.	—	—	10	2	—	—	—	—	—	6	—	50 (186)	68
Euphausia similis.....	—	—	—	—	—	—	—	—	—	—	—	1 (5)	1
Euphausia hanseni.....	—	—	—	—	—	1	—	—	1	—	—	— (2)	2
Euphausia mutica.....	—	—	—	—	—	—	—	—	—	—	—	—	—
Thysanoëssa gregaria.....	—	2	2	3	12	9	29	3	9	13	10	9	101
Thysanoëssa parva.....	—	—	—	—	—	—	—	—	—	—	—	—	—
Nematoscelis megalops.....	—	—	—	—	—	—	—	1	—	— (1)	5	2	8
Nematoscelis microps.....	—	—	—	—	—	—	—	1	—	—	—	— (1)	1
Stylocheiron carinatum.....	—	—	1	—	—	1	7	9	1	—	—	—	19
Stylocheiron longicorne.....	—	—	—	1	—	—	—	—	—	—	—	1	2
Stylocheiron maximum.....	—	—	—	1	—	—	—	—	—	—	—	—	1
Stylocheiron elongatum.....	—	—	—	—	—	—	—	—	—	—	—	1 (1)	1
Stylocheiron abbreviatum....	—	—	—	—	—	—	—	—	—	—	—	—	—
Stylocheiron affine.....	—	1	—	—	—	—	—	—	—	—	—	—	1
Nematobrachion flexipes.....	—	—	—	—	—	—	—	—	—	—	—	—	—
Total.....	3,701	1,296	2,117	1,904	1,026	2,551	4,969	2,049	20,257	6,564	27,962	18,691	93,087

Numbers caught at night stations are indicated in brackets.

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Table II.

Number of Euphausiids Found at Routine Stations. April, 1955—March, 1956.

	1955									1956			2nd Year Total	Total for 1954–1956
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March		
Euphausia lucens...	1,600	3,624	5,981	2,337	1,786	542	2,484	21,504	9,477	10,256	2,616	2,486	64,693	130,791
Nyctiphanes capensis.....	119	49	1,242	440	314	138	385	7,952	536	445	390	553	12,563	39,027
Euphausia recurva..	—	—	31	2	9	3	14	55	9	2	2	7	134	454
Euphausia similis var. *armata*.....	—	1	—	—	—	—	—	—	27	—	1	—	29	97
Euphausia similis...	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Euphausia hanseni..	—	—	—	—	—	—	—	—	—	—	—	—	—	2
Euphausia mutica..	—	—	—	—	—	—	—	—	—	—	—	1	1	1
Thysanoëssa gregaria.....	23	26	17	15	8	15	12	10	16	10	120	11	283	384
Thysanoëssa parva..	—	3	—	—	—	—	—	—	—	—	—	—	3	3
Nematoscelis megalops.....	3	3	—	—	—	—	—	1	6	3	11	46	73	81
Nematoscelis microps.....	—	—	—	—	—	—	—	1	1	—	—	—	2	3
Stylocheiron carinatum.....	3	—	2	—	—	—	2	—	1	—	—	—	8	27
Stylocheiron longicorne.....	—	—	3	2	5	2	—	3	—	1	—	—	16	18
Stylocheiron maximum.....	—	—	—	—	1	—	—	1	—	—	—	—	2	3
Stylocheiron elongatum.....	—	—	—	—	—	2	—	—	3	—	—	—	5	6
Stylocheiron abbreviatum.....	—	—	—	—	—	—	2	1	—	1	—	—	4	4
Stylocheiron affine..	—	—	—	—	—	—	1	1	—	—	—	—	2	3
Nematobrachion flexipes.....	—	—	—	—	1	—	—	—	—	—	—	—	1	1
Total....	1,748	3,706	7276	2,796	2,124	702	2,900	29,529	10,076	10,718	3,140	3,104	77,819	170,906

Table III.

Average Integral Temperature for the 0–50 Metres Layer, April, 1954—March, 1955. °C.

Station	1954									1955			Average
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	
A	18·92	17·62	15·83	15·03	14·45	14·86	16·17	17·17	17·33	13·96	14·91	14·44	15·89
B	16·63	17·51	15·03	14·77	14·94	14·65	15·67	15·71	16·01	14·33	15·10	15·63	15·49
C	14·93	14·34	15·43	14·87	14·25	15·10	15·80	16·90	15·95	14·83	14·60	14·31	15·11
D	14·80	14·61	14·12	14·44	13·96	14·89	15·09	14·86	13·97	13·55	14·44	13·71	14·37
E	13·65	15·55	14·85	14·46	13·77	14·67	15·37	13·51	14·71	14·18	14·64	14·15	14·46
F	16·23	13·57	16·25	14·60	14·22	14·75	15·27	16·71	17·24	14·71	13·09	14·02	15·06
G	17·04	16·62	16·04	14·94	14·42	14·93	15·54	14·44	16·99	14·26	11·84	14·24	15·11
H	12·93	14·47	15·37	14·77	14·16	14·94	15·23	13·88	16·50	12·05	11·85	13·61	14·15
I	13·64	14·94	15·26	14·39	14·04	14·81	14·13	14·65	15·51	12·94	12·45	12·87	14·14
J	13·82	15·59	14·95	14·91	14·23	14·49	12·68	12·15	13·54	13·16	12·96	13·86	13·86
K	11·53	13·23	12·98	14·03	13·97	12·80	12·65	12·97	12·19	12·68	12·19	12·77	12·83
L	11·32	11·30	13·18	13·24	13·45	12·22	12·07	10·74	11·22	12·54	11·39	11·57	12·02
M	12·53	14·07	11·46	11·67	13·11	10·49	9·67	9·79	9·76	10·37	11·19	9·90	11·17
N	11·10	14·05	13·35	12·69	12·38	11·27	10·14	10·15	10·67	11·12	10·77	10·02	11·48
O	12·17	12·50	13·65	14·44	12·97	12·49	12·65	10·15	11·17	12·15	11·79	11·92	12·34
Q	10·29	14·06	12·33	14·23	13·49	11·62	11·53	9·59	10·89	10·81	10·63	10·81	11·69
R	11·60	14·31	14·16	14·89	13·72	13·41	13·58	12·00	12·82	10·73	10·74	11·09	12·75
S	18·91	17·47	16·66	15·03	14·53	14·77	16·08	15·67	17·40	14·41	16·00	15·59	16·04
T	19·01	15·55	15·98	15·13	14·56	14·76	16·16	14·57	17·06	16·33	17·37	14·13	15·88
U	10·48	14·92	13·43	14·00	13·16	13·30	13·17	11·94	13·76	10·41	10·38	11·18	12·51
V	11·57	14·83	14·65	14·27	14·03	14·60	15·82	13·37	13·93	12·59	11·41	12·65	13·64
W	18·47	15·97	16·01	15·16	14·40	15·07	16·49	14·95	16·01	17·59	17·05	14·13	15·94
X	11·12	14·36	14·27	13·93	13·59	14·65	13·47	11·92	13·64	10·83	10·87	11·85	12·88
Average	14·03	14·85	14·58	14·34	13·90	13·89	14·11	13·38	14·27	13·07	12·94	12·98	13·86

Reprint from "Commerce & Industry", September, 1957

Table IV.

Average Integral Temperature for the 0–50 Metres Layer, April, 1955—march, 1956. °C.

Station	1955									1956			Average
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	
A	17·38	15·07	15·54	14·68	15·16	15·13	15·16	15·96	16·70	17·55	16·16	18·11	16·05
B	14·84	15·07	15·01	14·57	14·85	15·23	14·69	15·97	16·73	17·48	15·78	16·49	15·56
C	16·42	15·18	14·71	14·59	14·43	14·95	14·80	15·38	15·49	17·08	15·67	15·76	15·37
D	15·88	13·42	13·51	13·93	14·44	14·47	14·35	14·58	12·99	14·59	13·69	14·57	14·20
E	14·64	13·96	13·19	14·58	14·49	14·98	15·11	14·05	15·27	17·42	16·00	15·53	14·94
F	16·37	14·40	13·46	13·46	14·15	14·95	14·93	15·59	15·33	17·16	15·13	14·25	14·93
G	16·70	14·73	14·35	14·77	14·32	14·82	15·23	15·97	15·73	17·76	13·33	15·47	15·27
H	16·21	11·86	13·93	14·03	13·95	14·52	15·33	14·84	13·49	13·77	13·74	13·89	14·13
I	11·90	13·45	12·04	13·26	14·23	14·70	13·06	14·53	14·17	14·44	14·41	13·32	13·63
J	12·55	13·55	12·57	14·10	13·97	14·77	13·40	12·08	14·63	14·18	14·06	14·31	13·68
K	12·43	12·78	12·24	13·29	13·16	14·55	13·87	10·17	11·43	12·97	12·44	12·56	12·66
L	11·12	11·47	12·04	10·96	12·72	12·22	13·05	10·97	10·15	12·05	11·76	11·68	11·68
M	11·79	10·95	10·81	11·44	12·06	10·97	9·74	9·09	8·91	11·31	10·40	10·46	10·66
N	10·55	10·70	10·62	11·29	11·99	10·91	10·70	10·08	9·54	9·96	10·79	10·94	10·67
O	12·21	11·41	11·16	10·86	12·63	13·56	13·63	11·25	10·93	11·76	12·13	12·06	11·97
Q	11·64	10·60	10·95	11·39	12·50	13·17	12·05	9·63	9·79	11·17	11·38	10·23	11·21
R	11·35	11·34	10·50	14·08	13·09	13·61	14·30	10·66	11·69	11·19	11·71	12·54	12·17
T	16·80	14·86	15·23	14·67	14·16	14·97	15·31	16·23	16·87	17·41	14·00	17·55	15·67
U	10·71	11·64	12·33	13·03	13·89	13·83	13·59	10·89	13·28	11·51	11·26	11·04	12·25
V	12·27	12·23	12·78	14·29	14·00	14·48	14·93	13·61	16·32	13·43	13·81	12·59	13·73
W	17·00	15·13	14·55	14·81	14·41	14·93	15·29	16·60	17·02	18·99	16·12	15·72	15·88
X	12·65	12·09	11·13	13·38	13·52	14·09	13·49	12·50	12·27	10·86	12·32	13·13	12·62
Y	17·98	15·35	15·71	14·69	15·30	15·16	15·24	16·04	16·73	18·05	17·80	18·45	16·38
Z	17·15	15·78	15·53	14·63	15·13	15·27	15·14	15·72	16·81	18·44	18·95	18·32	16·41
Average	14·11	13·21	13·08	13·53	13·86	14·18	14·02	13·43	13·84	14·61	13·87	14·12	13·82

Table V.

Average Integral Salinity of the 0–50 Metres Layer, April, 1954—March, 1955. $^0/_{00}$

Station	1954									1955			Average
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	
A	35·54	35·45	35·26	35·29	35·32	35·35	35·43	35·39	35·34	35·03	35·23	35·03	35·31
B	35·27	35·42	35·13	35·26	35·39	35·35	35·34	35·26	35·23	35·06	35·19	35·19	35·26
C	35·19	35·10	35·21	35·30	35·27	35·35	35·40	35·42	35·25	35·21	34·92	35·08	35·23
D	35·12	35·08	35·00	35·22	35·15	35·35	35·29	35·09	35·04	34·91	34·89	34·87	35·08
E	35·04	35·23	35·08	35·23	35·15	35·32	35·34	35·03	35·06	35·04	34·94	35·04	35·13
F	35·15	34·98	35·30	35·24	35·28	35·35	35·31	35·41	35·36	35·04	34·92	34·87	35·18
G	35·32	35·28	35·29	35·35	35·30	35·36	35·40	35·18	35·32	35·17	35·08	35·04	35·26
H	34·95	35·02	35·22	35·29	35·27	35·36	35·35	35·12	35·30	34·86	34·76	34·83	35·11
I	35·09	35·15	35·22	35·21	35·26	35·35	35·14	35·23	35·29	34·95	34·93	34·87	35·14
J	35·01	35·23	35·16	35·34	35·27	35·33	34·96	34·94	35·13	34·92	34·89	34·86	35·09
K	34·85	34·95	34·87	35·17	35·21	35·00	35·07	34·94	34·79	34·92	34·80	34·86	34·95
L	34·81	34·77	34·82	35·06	35·11	34·95	34·93	34·72	34·71	34·74	34·75	34·77	34·85
M	34·78	34·79	34·81	34·63	34·94	34·77	34·72	34·69	34·66	34·71	34·75	34·76	34·75
N	34·77	34·79	34·81	34·88	34·96	34·77	34·69	34·66	34·69	34·71	34·77	34·75	34·77
O	34·83	34·83	35·00	35·25	35·09	35·01	34·95	34·72	34·70	34·82	34·77	34·77	34·90
Q	34·76	34·79	34·85	35·20	35·17	34·83	34·80	34·69	34·70	34·72	34·70	34·72	34·83
R	34·79	34·87	34·97	35·25	35·19	34·97	35·17	34·75	34·96	34·71	34·69	34·75	34·92
S	35·54	35·37	35·35	35·35	35·32	35·35	35·46	35·36	35·33	35·19	35·17	34·98	35·31
T	35·54	35·20	35·23	35·35	35·34	35·35	35·46	35·17	35·32	35·38	35·35	35·08	35·31
U	34·79	35·10	35·08	35·17	35·11	35·12	35·09	34·89	35·08	34·77	34·73	34·75	34·97
V	34·80	35·02	35·15	35·17	35·25	35·29	35·37	35·12	35·04	34·95	34·76	34·83	35·06
W	35·44	35·16	35·24	35·35	35·32	35·36	35·43	35·18	35·18	35·40	35·31	35·08	35·29
X	34·79	34·85	35·06	35·16	35·16	35·31	35·11	34·85	34·99	34·76	34·72	34·76	34·96
Average	35·05	35·06	35·09	35·21	35·21	35·20	35·18	35·04	35·06	34·96	34·91	34·89	35·07

Reprint from "Commerce & Industry", September, 1957

Table VI.

Average Integral Salinity of the 0–50 Metres Layer, April, 1955—March, 1956. $^0/_{00}$

Station	1955									1956			Average
	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	
A	35·36	35·08	35·20	35·26	35·30	35·35	35·41	35·41	35·38	35·30	35·16	35·38	35·30
B	35·06	35·08	35·17	35·21	35·25	35·35	35·22	35·40	35·39	35·34	35·08	35·12	35·22
C	35·23	35·16	35·16	35·25	35·21	35·31	35·29	35·18	35·23	35·23	34·97	35·10	35·19
D	35·20	35·06	34·99	35·21	35·22	35·18	35·22	35·14	35·00	34·99	34·89	35·12	35·10
E	35·20	35·07	34·97	35·26	35·19	35·32	35·29	35·08	35·23	35·25	35·05	35·01	35·16
F	35·24	35·13	35·03	35·05	35·19	35·33	35·36	35·34	35·23	35·37	34·95	34·90	35·18
G	35·25	35·13	35·14	35·25	35·21	35·37	35·60	35·39	35·27	35·37	34·92	35·15	35·25
H	35·25	34·92	35·13	35·17	35·09	35·34	35·34	35·31	35·04	34·95	34·90	34·98	35·12
I	34·91	35·01	34·91	35·09	35·15	35·34	35·00	35·22	35·07	35 07	35·15	34·85	35·06
J	34·96	35·04	34·96	35·19	35·13	35·35	35·08	34·99	35·16	35·11	34·94	34·88	35·07
K	34·89	34·89	34·79	35·12	35·01	35·32	35·16	34·74	34·88	34·80	34·82	34·83	34·94
L	34·77	34·83	34·75	34·75	34·95	34·94	35·08	34·74	34·69	34·73	34·78	34·81	34·82
M	34·75	34·79	34·73	34·71	34·77	34·75	34·67	34·64	34·64	34·71	34·72	34·70	34·72
N	34·72	34·76	34·75	34·79	34·61	34·76	34·73	34·69	34·67	34·65	34·67	34·69	34·71
O	34·93	34·83	34·78	34·82	34·89	35·17	35·15	34·75	34·86	34·81	34·87	34·71	34·88
Q	34·85	34·77	34·78	34·67	34·76	35·12	34·94	34·69	34·66	34·73	34·69	34·69	34·78
R	34·77	34·85	34·74	35·18	34·97	35·10	35·19	34·74	34·94	34·68	34·78	34·87	34·90
T	35·33	35·19	35·22	35·25	35·17	35·37	35·41	35·39	35·42	35·34	34·94	35·30	35·28
U	34·80	34·91	34·95	35·06	35·11	35·24	35·15	34·83	35·11	34·78	34·77	34·84	34·96
V	34·96	34·94	35·03	35·22	35·35	35·25	35·26	35·11	35·30	34·92	34·94	35·00	35·11
W	35·34	35·25	35·15	35·26	35·21	35·37	35·39	35·41	35·38	35·41	35·16	35·11	35·29
X	34·96	34·93	34·76	35·09	34·99	35·19	35·11	34·98	34·88	34·68	34·81	34·82	34·93
Y	35·36	35·19	35·24	35·25	35·28	35·37	35·41	35·38	35·41	35·38	35·28	35·34	35·32
Z	35·29	35·21	35·22	35·25	35·30	35·39	35·41	35·38	35·42	35·41	35·46	35·35	34·34
Average	35·06	35·00	34·98	35·10	35·10	35·23	35·20	35·08	35·09	35·04	34·95	34·98	35·06

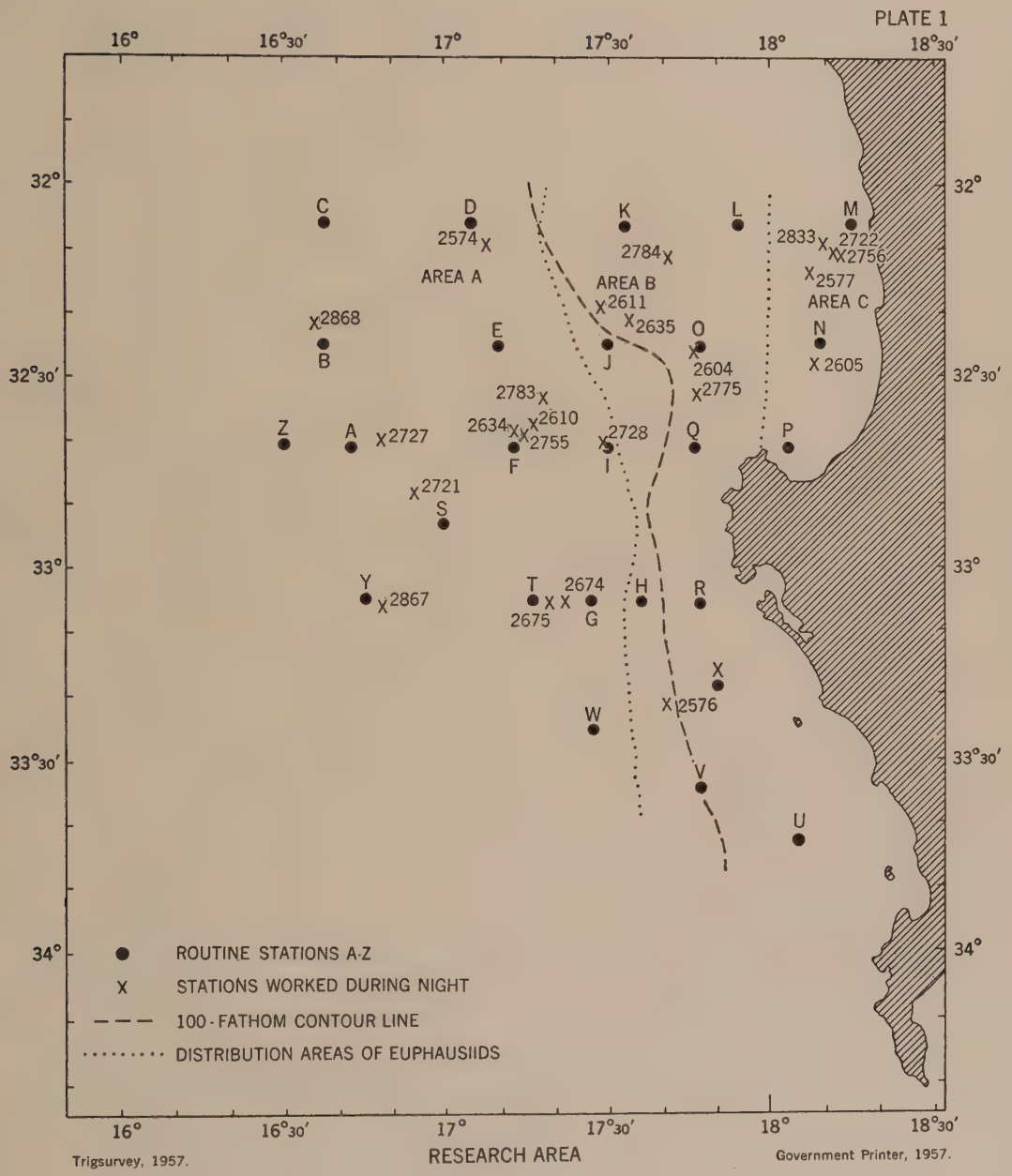
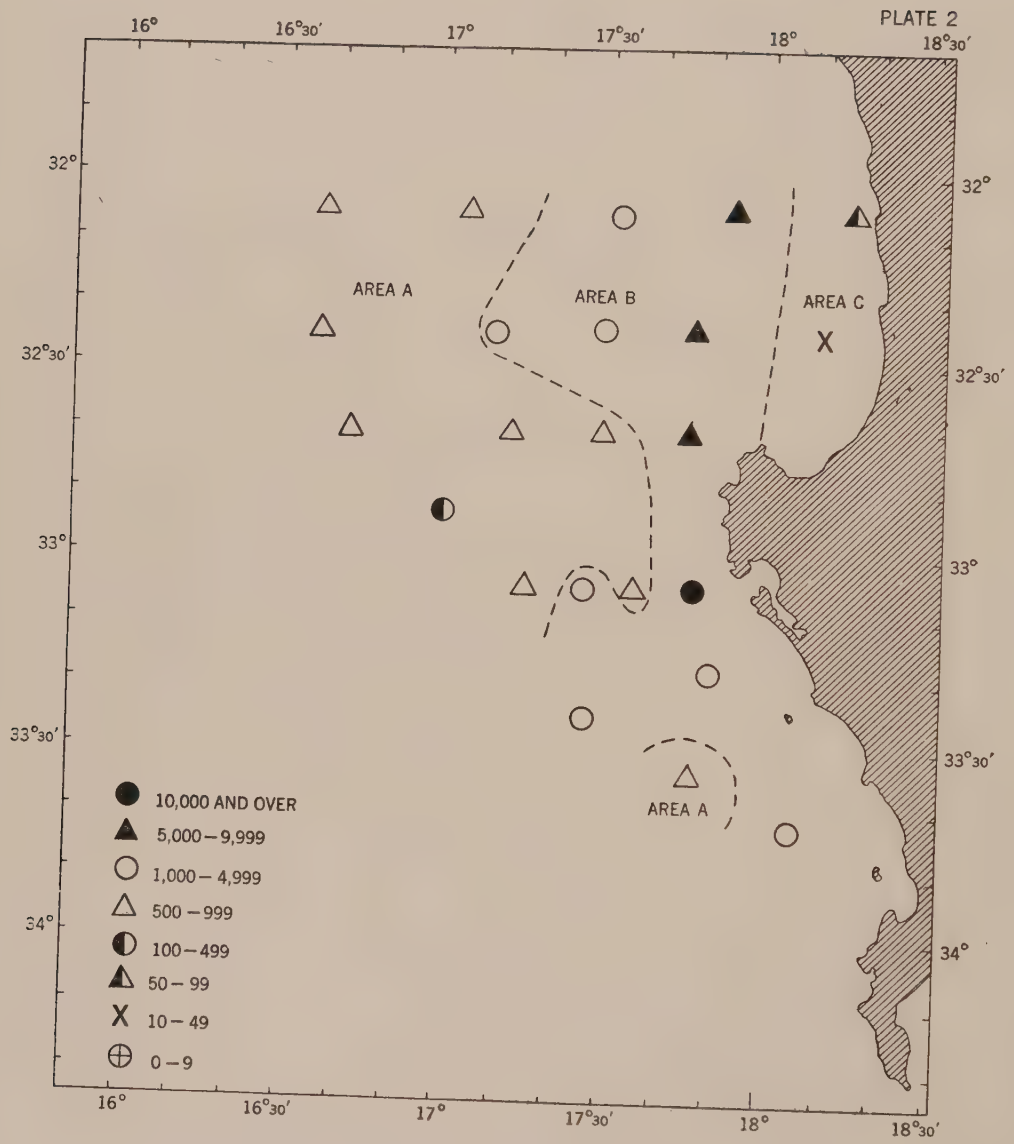


PLATE 1
16°
16°30′
17°
17°30′
18°
18°30′
32°
32°30′
33°
33°30′
34°
C
D
2574
K
2784
L
M
2833
2722
2756
2577
AREA A
AREA B
AREA C
2868
B
E
2611
2635
J
O
2604
2775
N
2605
2783
2634
2610
2755
2728
Z
A
2727
F
I
Q
P
2721
S
Y
2867
T
2674
2675
G
H
R
X
2576
W
V
U
ROUTINE STATIONS A-Z
STATIONS WORKED DURING NIGHT
100-FATHOM CONTOUR LINE
DISTRIBUTION AREAS OF EUPHAUSIIDS
RESEARCH AREA
Trigsurvey, 1957.
Government Printer, 1957.

PLATE 2

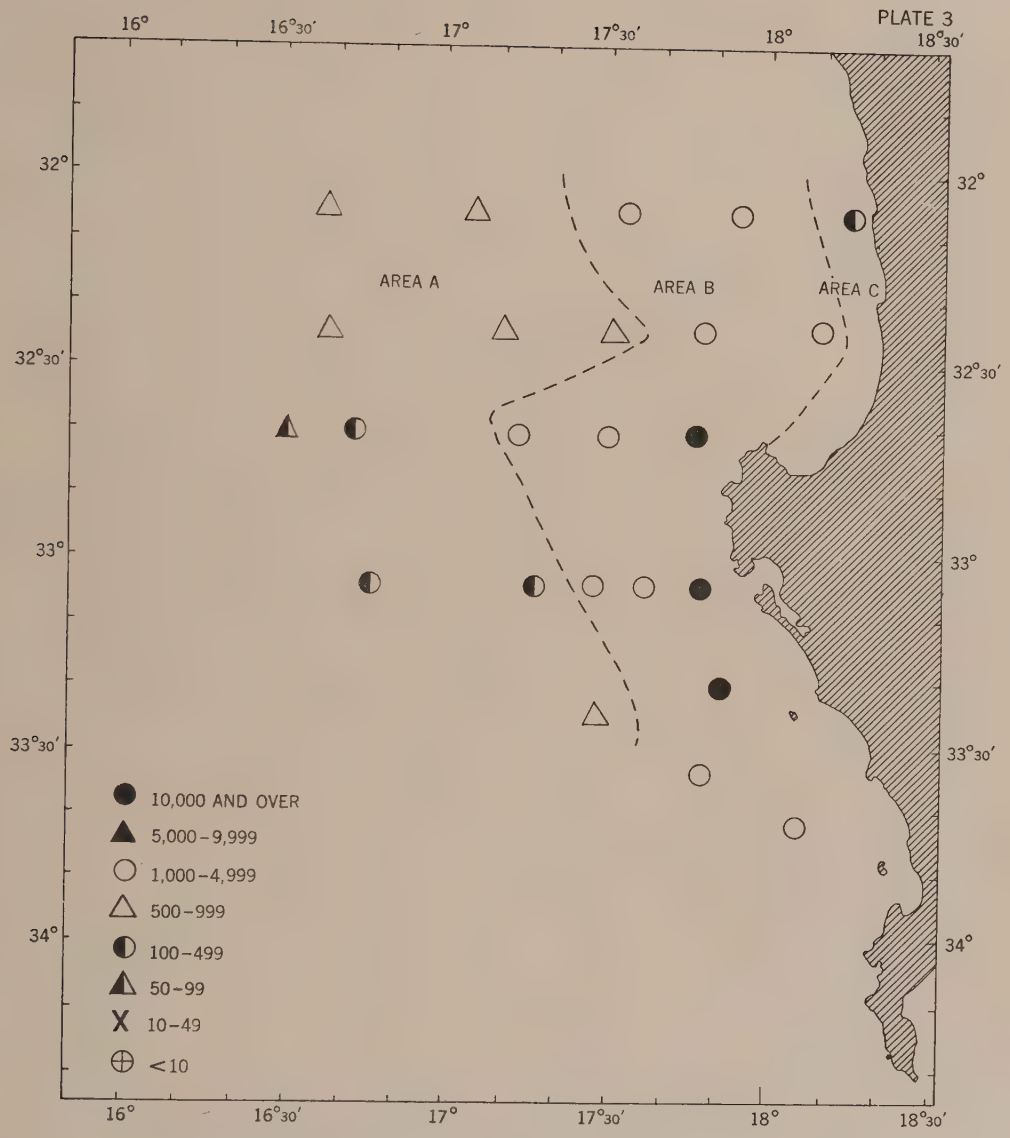


DENSITY DISTRIBUTION OF EUPHAUSIA LUCENS, APRIL, 1954–MARCH, 1955

Trigsurvey, 1957.

Government Printer, 1957.

PLATE 3

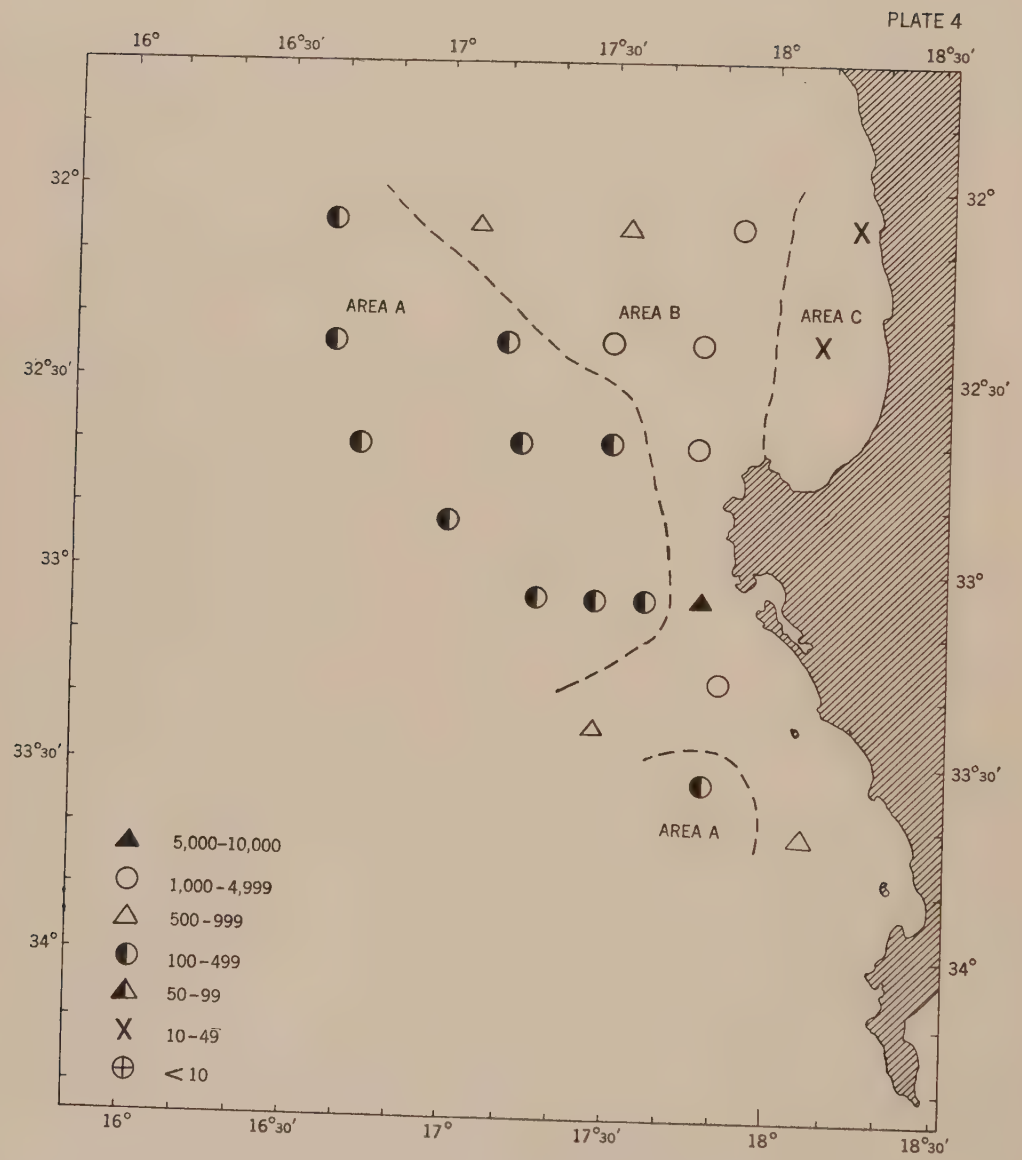


DENSITY DISTRIBUTION OF EUPHAUSIA LUCENS, APRIL, 1955–MARCH, 1956

Trigsurvey, 1957.

Government Printer, 1957.

PLATE 4

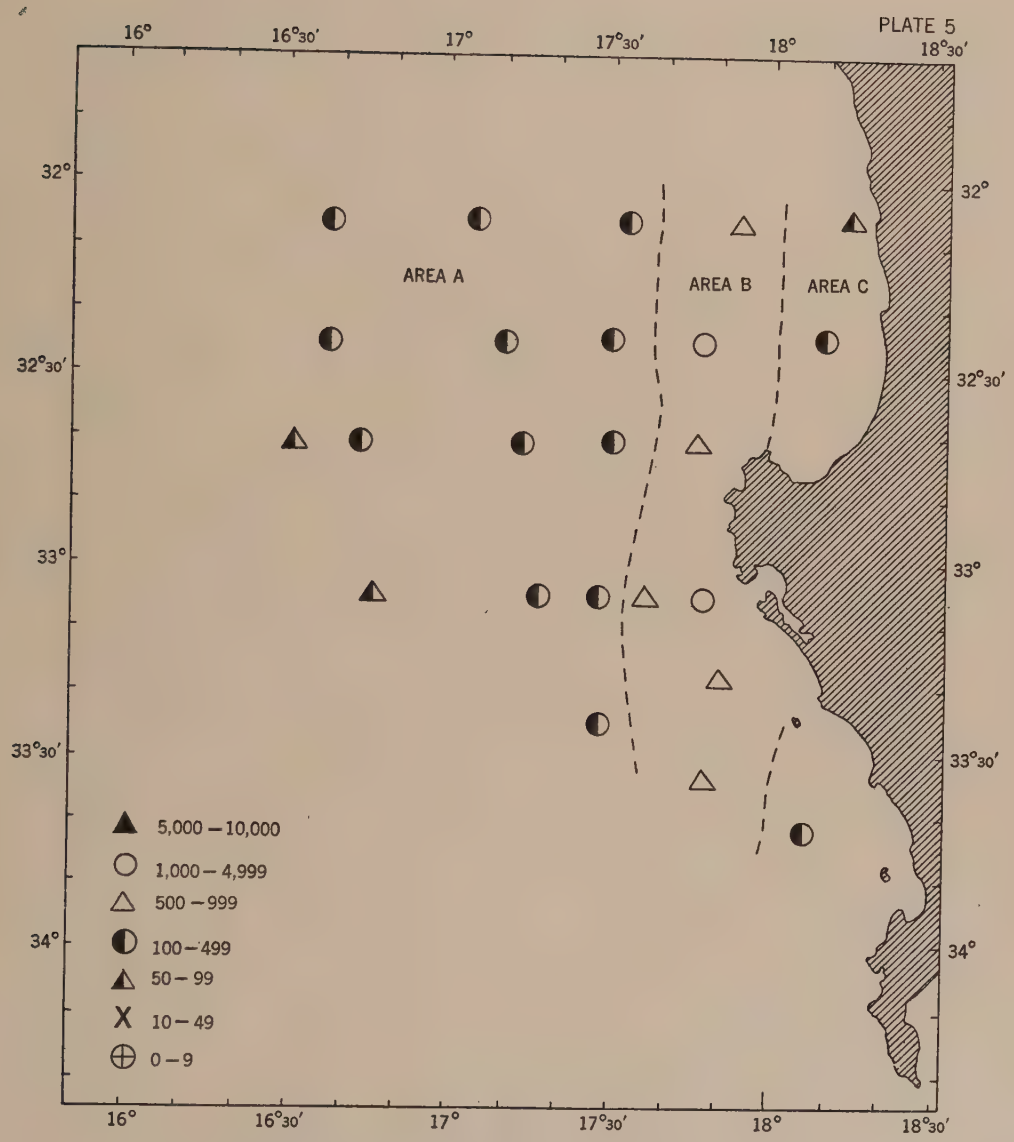


DENSITY DISTRIBUTION OF EUPHAUSIA LUCENS LARVAE, APRIL, 1954–MARCH, 1955

Trigsurvey, 1957.

Government Printer, 1957.

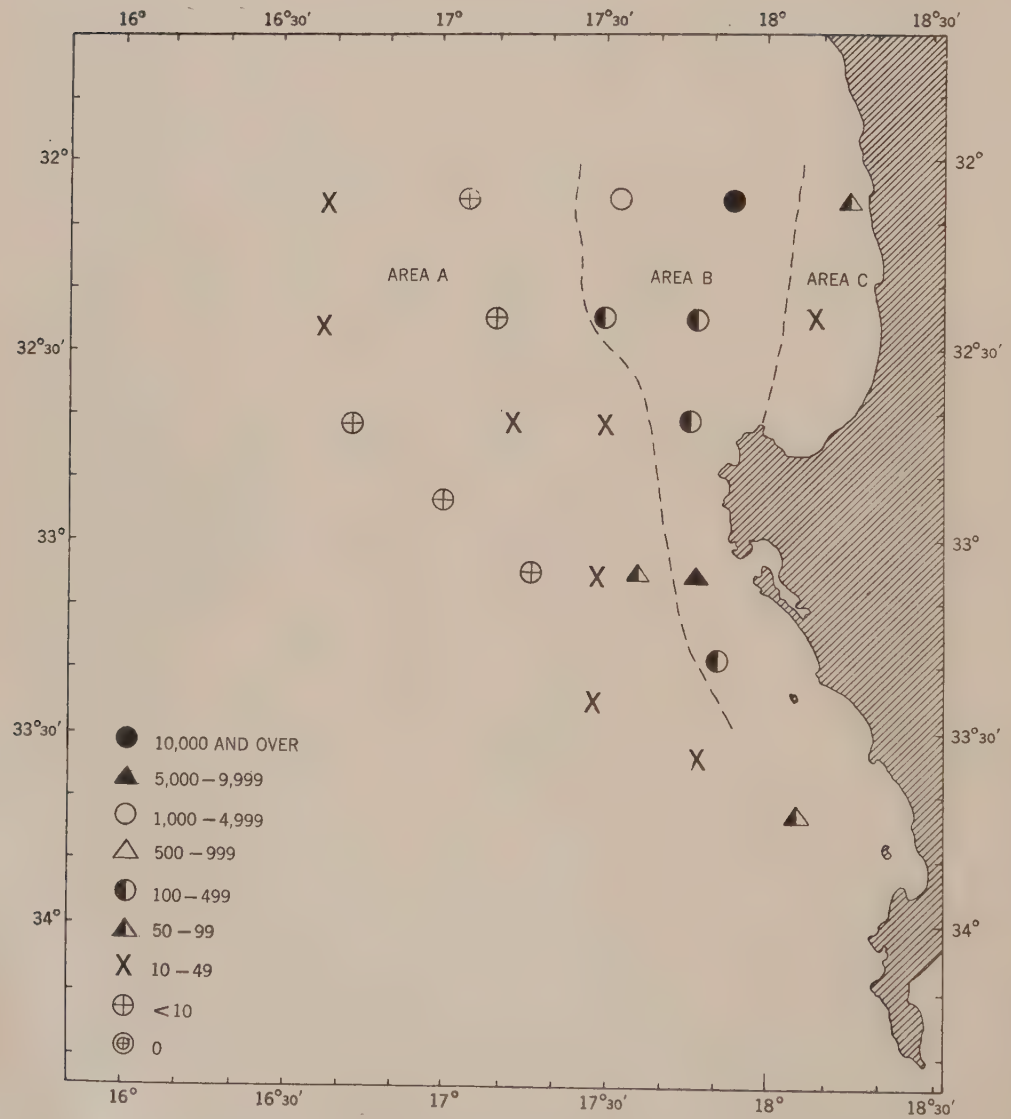
PLATE 5



DENSITY DISTRIBUTION OF EUPHAUSIA LUCENS LARVAE, APRIL, 1955–MARCH, 1956

Trigsurvey, 1957. Government Printer, 1957.

PLATE 6

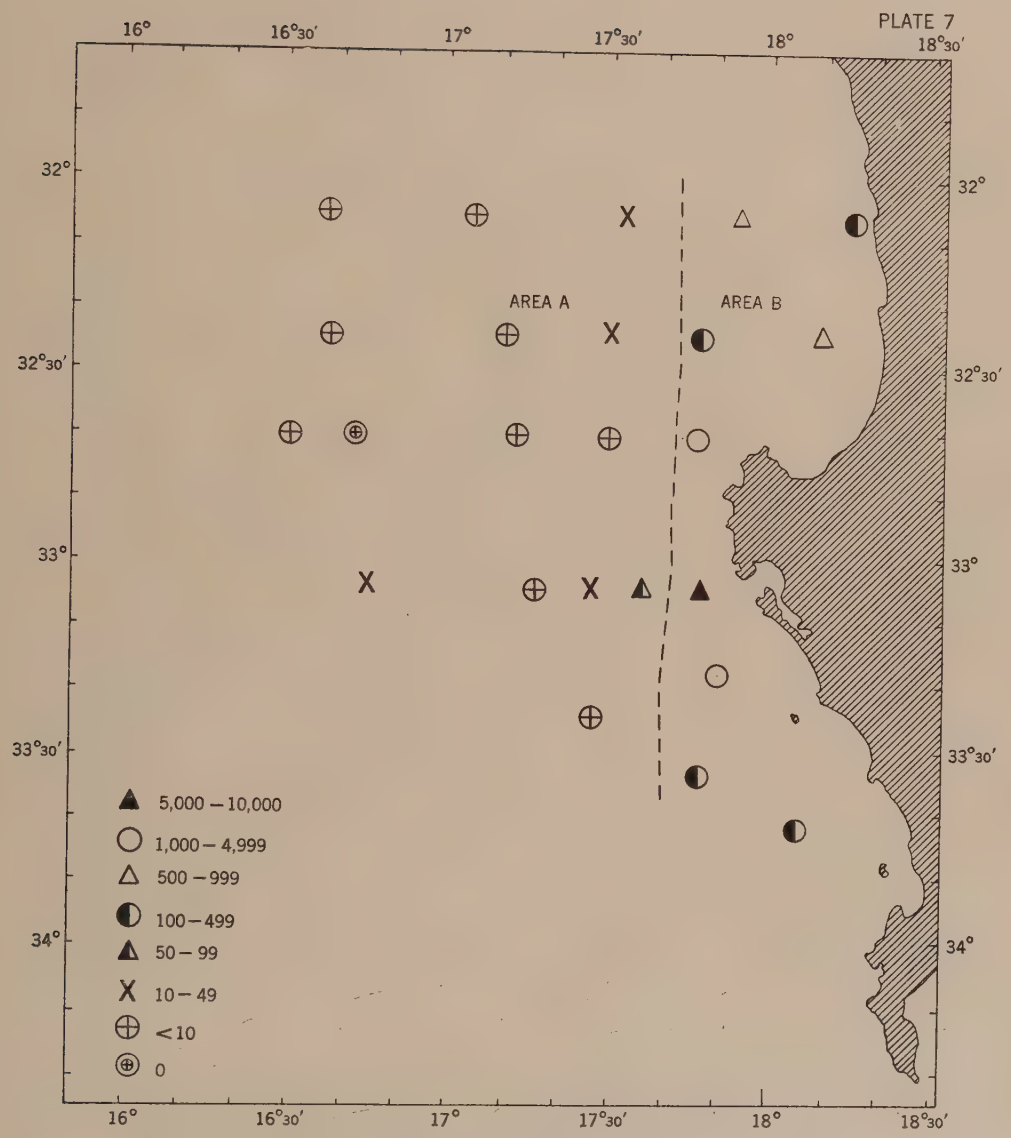


DENSITY DISTRIBUTION OF NYCTIPHANES CAPENSIS, APRIL, 1954–MARCH, 1955

Trigsurvey, 1957.

Government Printer, 1957.

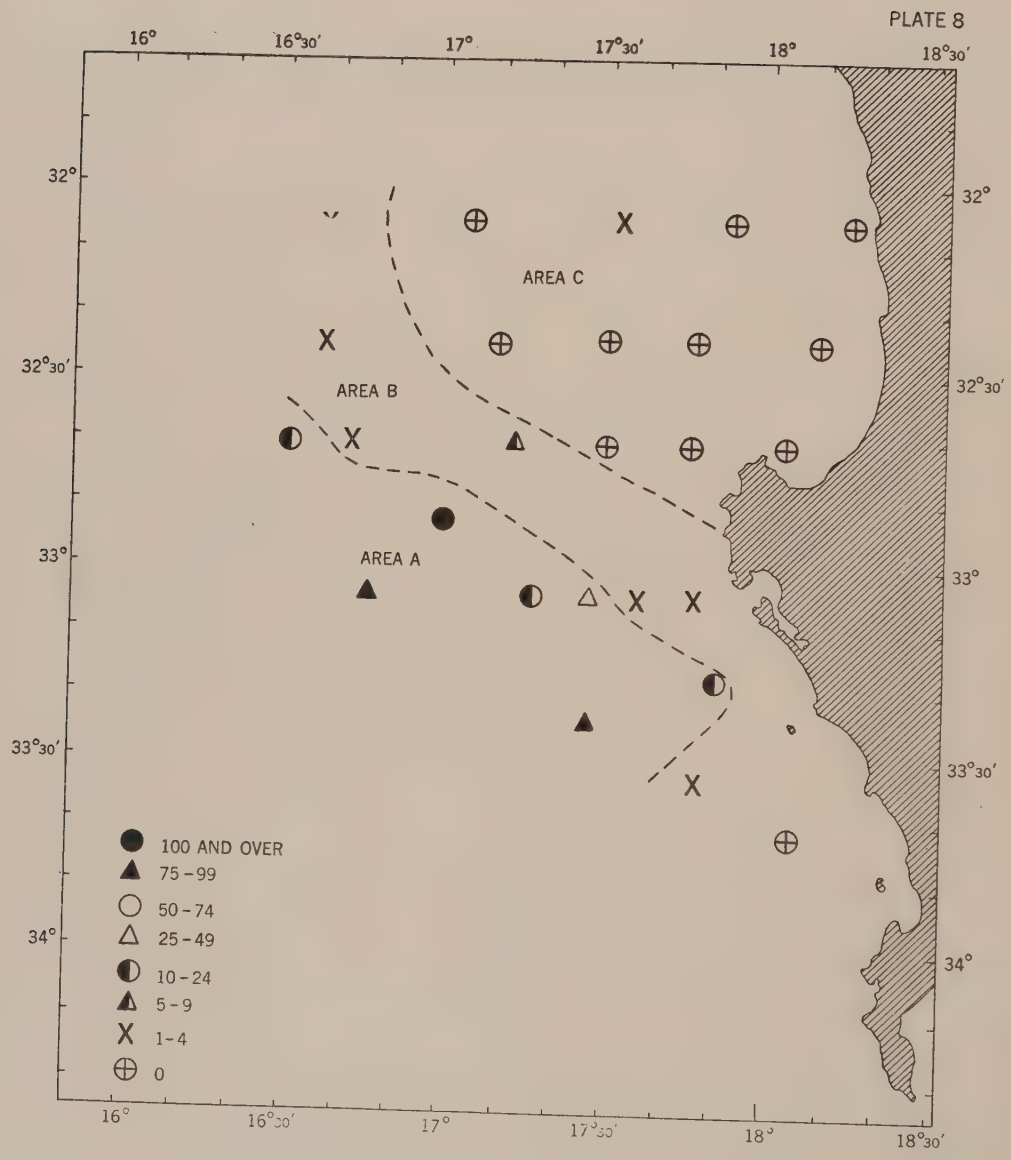
PLATE 7



DENSITY DISTRIBUTION OF NYCTIPHANES CAPENSIS, APRIL, 1955–MARCH, 1956

Trigsurvey, 1957. Government Printer, 1957.

PLATE 8

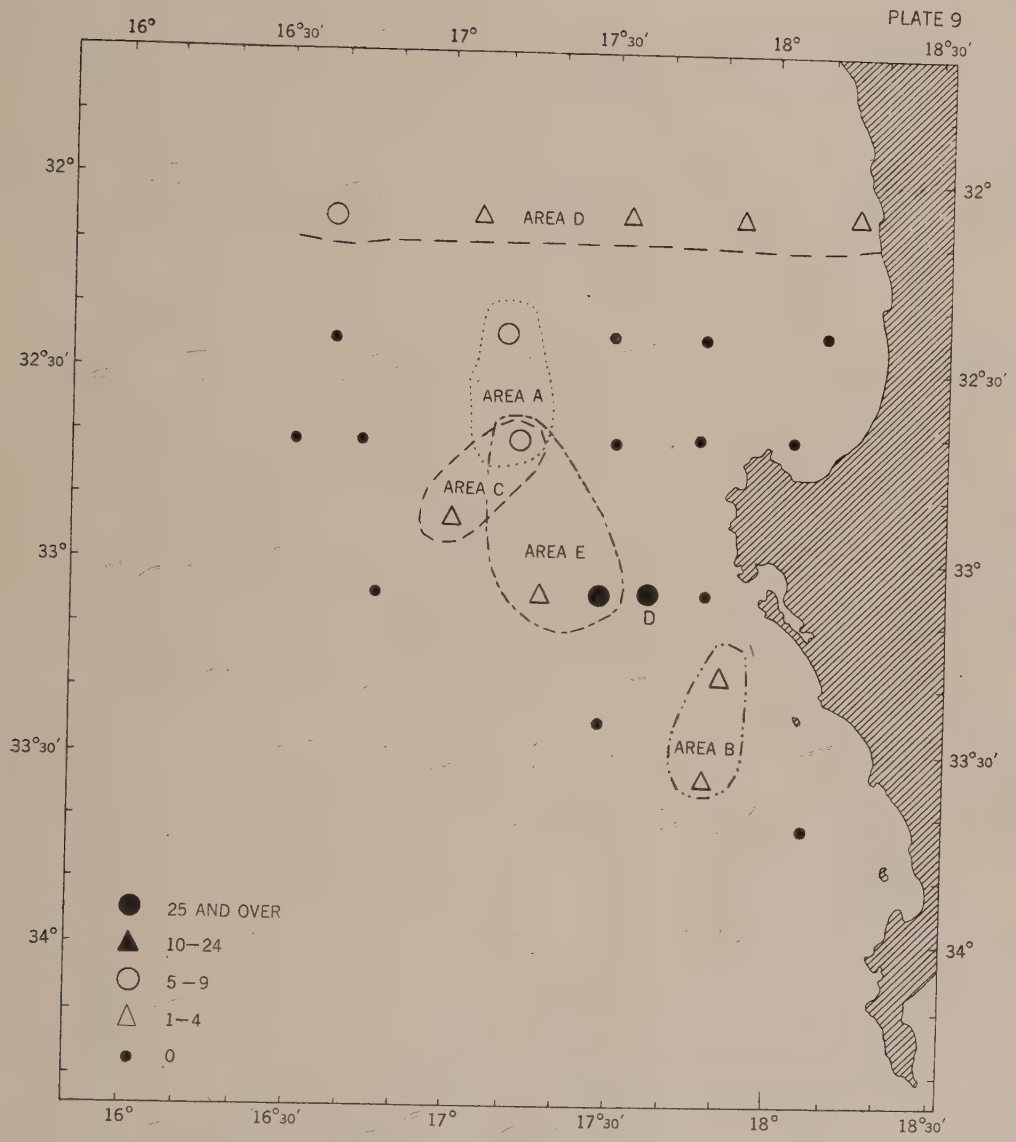


DENSITY DISTRIBUTION OF EUPHAUSIA RECURVA, APRIL, 1954–MARCH, 1956

Trigsurvey, 1957.

Government Printer, 1957.

PLATE 9

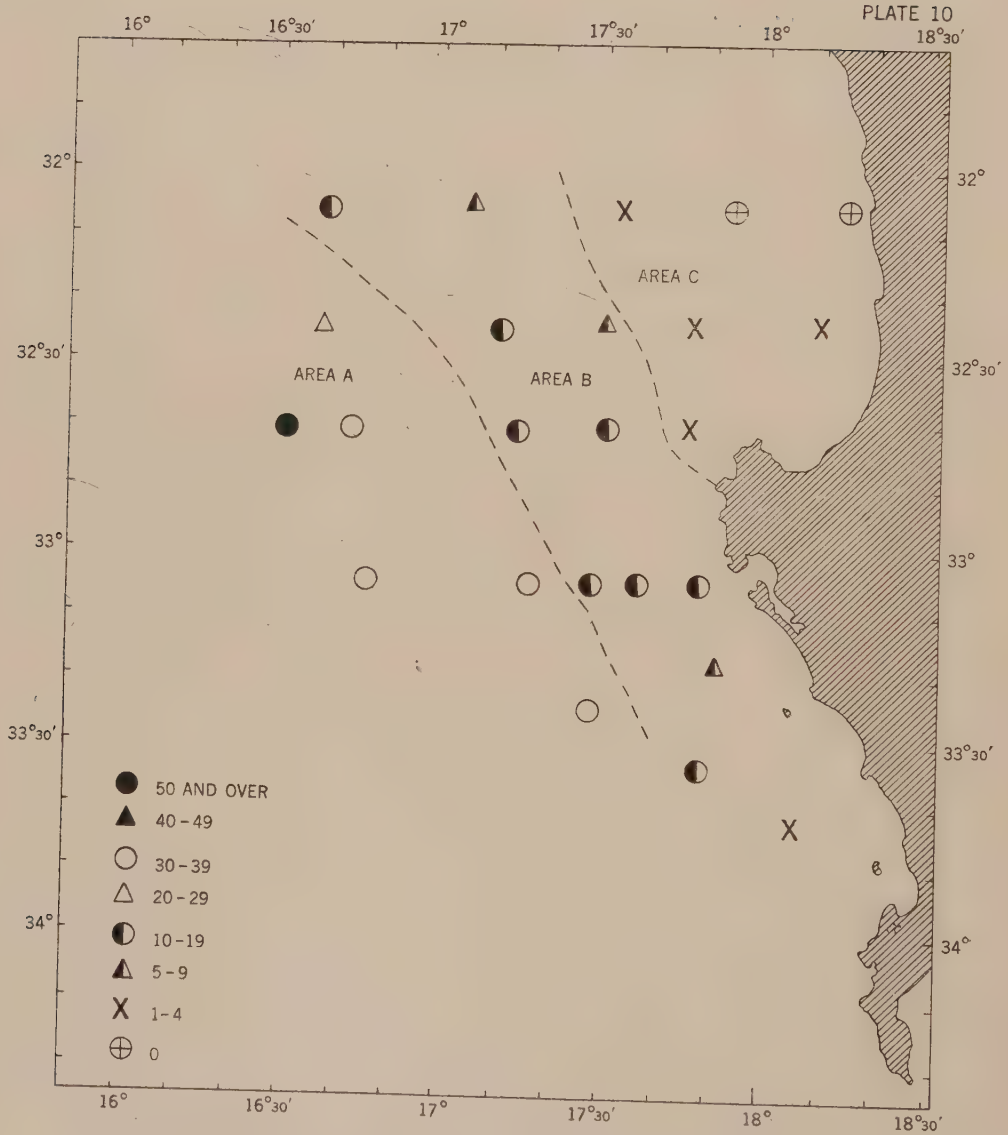


DENSITY DISTRIBUTION OF EUPHAUSIA SIMILIS VAR. ARMATA, APRIL, 1954–MARCH, 1956

Trigsurvey, 1957.

Government Printer, 1957.

PLATE 10

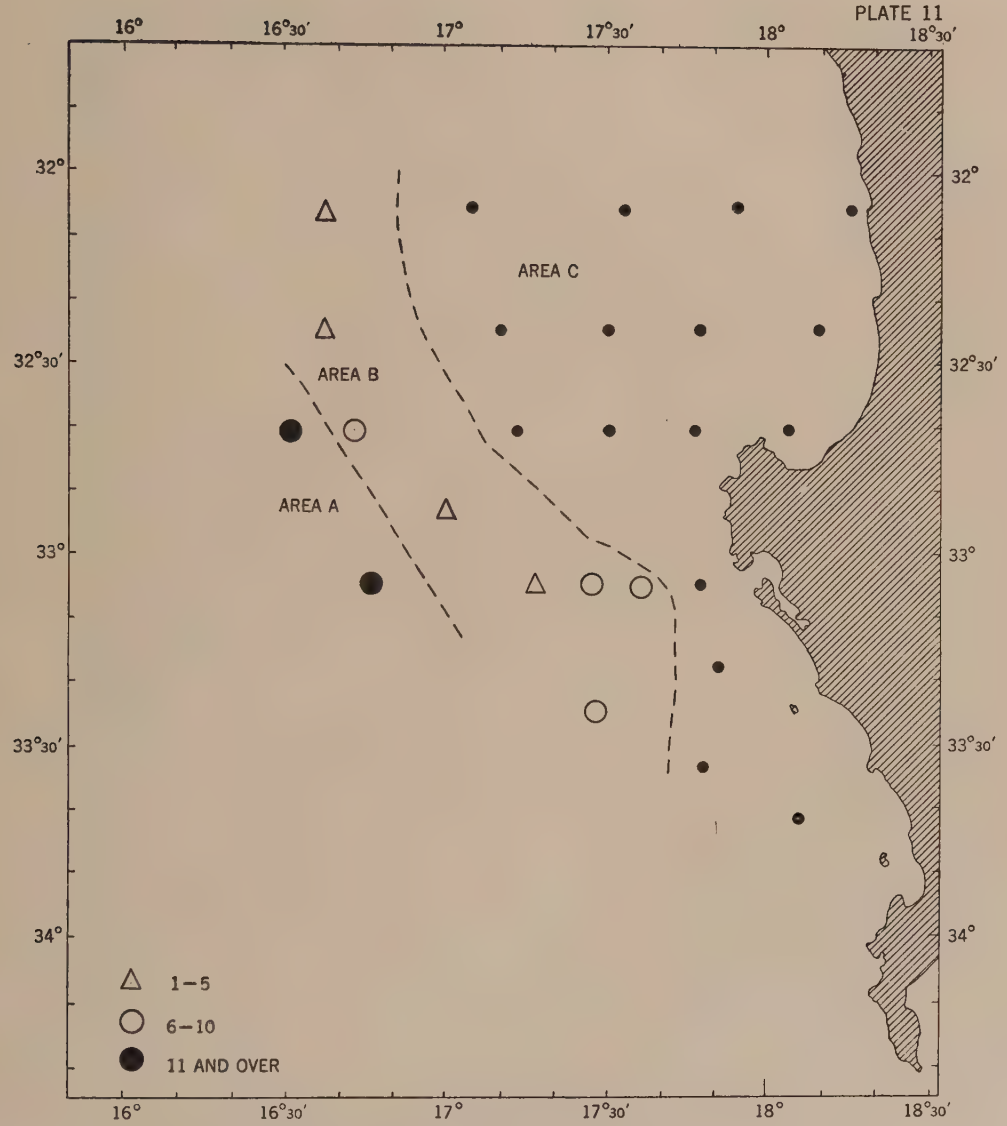


DENSITY DISTRIBUTION OF THYSANOËSSA GREGARIA, APRIL, 1954 - MARCH, 1956

Trigsurvey 1957

Government Printer, 1957.

PLATE 11



DENSITY DISTRIBUTION OF NEMATOSCELIS MEGALOPS, APRIL, 1954–MARCH, 1956

Trigsurvey, 1957. Government Printer, 1957.

PLATE 12

DISTRIBUTION OF LESS COMMON SPECIES OF EUPHAUSIIDS, APRIL, 1954–MARCH, 1956

Trigsurvey, 1957.

Government Printer, 1957.